REMARKS

In the Final Office Action dated April 3, 2006 ("FOA"), claims 1-20 were rejected under 35 USC §§ 101, 112 and 103. By this Amendment, claims 1, 5, 9 and 13 are amended. Currently pending claims 1-23 are believed allowable, with claims 1, 5, 9 and 13 being independent claims.

CLAIM REJECTIONS UNDER 35 USC §101:

Claims 1, 5, 9 and 13

Claims 1, 5, 9 and 13 were rejected under 35 USC § 101 as allegedly reciting non-statutory subject matter. The Examiner argues that these claims are non-statutory for two reasons. First, the claims pertain to a "program per se and are non-statutory since said program is not embodied in a tangible computer-readable medium." Second, the Examiner argues that the claims "do not produce a useful concrete and tangible result." The Applicant responds to each allegation below.

As to the argument that claims 1, 5, 9 and 13 pertain to a program per se not embodied in a tangible computer-readable medium, claims 1 and 5 recite a signal processing method for a digital signal. Claims 1 and 5 do not contain language directed specifically toward a computer program. Claims 9 and 13 both recite a program, but each claim contains limitations restricting the program to a tangible computer-readable medium. Thus, the Applicant respectfully disagrees with the Examiner's characterization of claims 1, 5, 9 and 13.

As to the argument that claims 1, 5, 9 and 13 do not produce a useful, concrete and tangible result, claims 1, 9 and 13 are amended herein to recite the operation of "correcting at least one error in the digital signal." Claim 5 is amended to recite "means for removing at least one error in the digital signal." Support for these amendments can be found at least on page 20, line 15 - page 21, line 1, page 23, lines 13-16, and page 66, lines 17-24. The Applicants submit that the correcting at least one error in a digital signal produces a useful, concrete and tangible result.

For at least these reasons, the Applicant respectfully submits that claims 1, 5, 9 and 13 recite statutory subject matter under 35 USC § 101.

Claims 2-4, 6-8, 10-12 and 14-23 are believed to also recite statutory subject matter for at least the same reasons as the independent claims they are dependent on.

<u>CLAIM REJECTIONS UNDER 35 USC §112:</u>

<u>Claims 5 and 21-23</u>

Claims 5 and 21-23 were rejected under 35 USC § 112 as allegedly failing to comply with the enablement requirement. OA, ¶ 4. The Examiner argues that the limitation of "obtaining the solution of Yule-Walker equation <u>without conditional branching</u>" is not enabled by the specification.

The Applicant respectfully submits that obtaining the solution of Yule-Walker equation without conditional branching is enabled by the specification. As described in the specification, the invention utilizes the Peterson approach to solve the Yule-Walker equation directly. App., pg. 47, ln. 1-9. Using Jacobi's formula, the calculation of $\Lambda_i^{hat(l)}$ results in the calculation of $\Gamma_i^{(l+1)}$, given by the symmetric matrices

$$\Gamma_i^{(l+1)} = \begin{vmatrix} S_0 & \cdots & S_{l-1-i} & S_{l+1-i} & \cdots & S_l \\ \vdots & & \vdots & \vdots & & \vdots \\ S_{l-1-i} & \cdots & S_{2(l-1-i)} & S_{2(l-i)} & \cdots & S_{2l-1-i} \\ S_{l+1-i} & \cdots & S_{2(l-i)} & S_{2(l+1-i)} & \cdots & S_{2l+1-i} \\ \vdots & & \vdots & \vdots & & \vdots \\ S_l & \cdots & S_{2l-1-i} & S_{2l+1-i} & \cdots & S_{2l} \end{vmatrix}$$

App., pg. 56, ln. 1-3. Those skilled in the art will appreciate that this branchless algorithm is suitable for a combinational circuit and can reduce the number of multipliers thanks to the symmetry of $\Gamma_i^{(l+1)}$. App., pg. 56, ln. 14-27. Thus, the Applicants respectfully submit that the specification enables those skilled in the art to obtain a solution of Yule-Walker equation without conditional branching, as recited in claims 21-24. App., pg. 46, ln. 22-26.

In response, the Examiner states that the citation on page 46, lines 22-26 is the only reference to the limitation of "without conditional branching." FOA, pg. 6. This citation states, "In order to implement the Yule-Walker equation by a combinational circuit, an algorithm that has no conditional branching must be found, and this is an essential object for the algorithm of the invention." App., ln. 22-26. As discussed above, however, the Application provides someone skilled in the art an enabling disclosure for obtaining a solution of the Yule-Walker equation without conditional branching by solving the symmetrical matrix for $\Gamma_i^{(i+1)}$. Thus, the Applicants respectfully do not agree with the Examiner's position.

CLAIM REJECTIONS UNDER 35 USC §103:

Claims 1-23 were rejected under 35 USC §103 as obvious over U.S. Patent Application Publication No. US 2001/0053225 A1 to Ohira et al. (hereinafter "Ohira") in view of Zang et al., On the Methods for Solving Yule-Walker Equations, IEEE Transactions of Signal Processing, Vol. 40, No. 12 (Dec. 1992) (hereinafter "Zang") and further in view of U.S. Patent No. 4,694,455 to Koga et al. (hereinafter "Koga"). OA, ¶ 6.

A *prima facie* case for obviousness can only be made if the combined reference documents teach or suggest all the claim limitations. MPEP 2143.

Claim 1

Claim 1 recites, in part, "establishing a Yule-Walker equation . . . by using a matrix that includes, as components, the elements of a Galois field GF(2^m) applied to Reed-Solomon codes having an odd minimum distance, and a vector that includes, as components, said elements of said Galois field GF(2^m)." In rejecting claim 1, the Examiner alleges that Koga suggests a solution Reed-Solomon codes having an arbitrary minimum distance since the reference states, at column 14, lines 15-17, the "invention provides an error correction equipment with simple circuitry that can decode any received code word with reduced quantity of calculation." OA, pg. 2 and 9. The Applicant respectfully disagrees with the Examiner's interpretation of Koga.

Although Koga teaches error correction equipment with simple circuitry that can decode any received code word, this reference deals

only with binary BCH codes since the syndrome relation $S_{2i}=S_i^2$ has to hold. Koga, col. 2, ln. 55-61. On the other hand, the technique of the present application is applicable to binary and non-binary codes over $GF(2^m)$. App., pg. 35, ln. 16-18. As further evidence, a more recent paper written by the same author, Koga, "A Simple Decoding of BCH Codes Over GF(2m)", IEEE Transactions on Communications, vol. 46, no. 6 (June 1998), submitted herewith in an Information Disclosure Statement, extends the Koga method to non-binary BCH codes over GF(2m). However, the paper also teaches that in order for ${}_{i;i+2u}D(X,Y)$ to exist for $u \leq t$ and to be used for error correction, there have to be 2t+1 syndromes, which makes the proposed method applicable only to even minimum distance codes.

The technique of the present invention has no such limitation since it does not need 2t+1 th syndrome S_{2t} thanks to the use of Jacobi's formula, even when the minimum distance is odd. In addition, this makes the present invention advantageous over Koga in the number of necessary multipliers.

Beyond the Koga reference, Examiner appears to take the position that the Yule-Walker equation can be applied to any Reed-Solomon code. In response, the Applicant respectfully requests evidence in the record demonstrating that it would be obvious to a person of ordinary skill in the art at the time the present invention was made that elements of a Galois field $GF(2^m)$ applied to Reed-Solomon codes having an odd minimum distance, as recited in claim 1.

Thus, it is respectfully submitted that Ohira, in combination with Zang and Koga do not teach or suggest all the limitations of claim 1. For at least this reason, claim 1 is allowable.

Claims 2-4

Claims 2-4 are dependent on further limit claim 1. Since claim 1 is believed allowable, claims 2-4 are also believed allowable for at least the same reasons as claim 1.

Claim 17

Claim 17 recites "The signal processing method according to claim 1, wherein obtaining the solution of said Yule-Walker equation is limited to addition and multiplication operations." In rejecting claim

17, the Office Action alleges that Zhang, at Table III, page 2997, teaches the limitations of claim 17. No other reference in the art is cited by the Examiner for teaching such a limitation.

Table III of Zhang is titled, "Numbers of Multiplication Required for Each Algorithm Where a/b: Forward or Backward Predictor to be Computed and a+b: Forward and Backward Predictors to be Computed." The table compares the number of multiplications of the Levinson, Euclidean and Berlekamp algorithms for both forward and backward predictors. The Applicant respectfully submits, however, that nowhere in Zhang, including Table III, is there a teaching or suggestion that the solution of the Yule-Walker equation be limited to addition and multiplication operations, as recited in claim 17.

Thus, the Applicant respectfully submits that the references of record do not teach or suggest the limitations of claim 17. As such, allowance of claim 17 is earnestly solicited.

Claim 21

Claim 21 recites "The signal processing method according to claim 1, wherein obtaining the solution of said Yule-Walker equation is performed without conditional branching." In rejecting this limitation the Examiner states, "the prior art of record is silent on conditional branching, which would lead one skilled in the art that conditional branching or no conditional branching would be an option to one skilled in the art." OA, pg. 3. The Applicant respectfully disagrees with this conclusion.

As discussed in the pending Application, it is inevitable that multiple conditional branches would be included in the Berlekamp-Massey algorithm (to determine whether the denominator is zero or not). App., pg. 46, ln. 1-4. In the Euclid method, the degree of the polynomial that appears in the denominator of the division cannot be identified in advance; therefore there is a need to generate a conditional branch as well. App., pg. 46, ln. 7-14. It is noted that all possible computational paths must be statically implemented in advance in order for an algorithm to be realized as combination circuits. Although the existing algorithms such as Levinson, Berlekamp-Massey or Euclid could be implemented as combinational circuit, the resulting decoders would be have impractically large circuit size due to their conditional

branches at every division inside the algorithm. Thus, the Applicant respectfully disagrees with the Examiner's conclusion that since the cited art is silent on conditional branching, "conditional branching or no conditional branching would be an option to one skilled in the art."

The Examiner argues that the Applicant's "mere statements" are not considered evidence of record and requests the Applicant to cite prior art "which teaches that aforementioned algorithms can <u>only</u> be implemented with conditional branching." OA, pg. 3 (emphasis in original). It is respectfully submitted that the Examiner's position places an unwarranted requirement on the Applicant. It is the Patent Office's burden to demonstrate that the prior art teaches or suggests limitations claimed by the Applicant. The Examiner has stated that the prior art of record is silent on conditional branching and the Applicant has explained, not by "mere statements", but by reasoned analysis that the algorithms of Levinson, Berlekamp-Massey and Euclid require conditional branching.

For that least these reasons, and the reasons given for claim 1, the Applicant respectfully submits that claim 21 is not obvious over the cited art and earnestly solicits allowance of the claim.

<u>Claim 5</u>

Claim 5 recites, in part, "means for establishing a Yule-Walker . . . means for obtaining the solution of said Yule-Walker equation without conditional branching." In rejecting claim 5, the Examiner states, "the prior art of record is silent on conditional branching, which would lead one skilled in the art that conditional branching or no conditional branching would be an option to one skilled in the art." FOA, pg. 7. The Applicant respectfully disagrees with this conclusion.

As discussed in the pending Application, it is inevitable that multiple conditional branches would be included in the Berlekamp-Massey algorithm (to determine whether the denominator is zero or not). App., pg. 46, ln. 1-4. In the Euclid method, the degree of the polynomial that appears in the denominator of the division cannot be identified in advance; therefore there is a need to generate a conditional branch as well. App., pg. 46, ln. 7-14. It is noted that all possible computational paths must be statically implemented in advance in order for an algorithm to be realized as combination circuits. Although the

existing algorithms such as Levinson, Berlekamp-Massey or Euclid could be implemented as combinational circuit, the resulting decoders would be have impractically large circuit size due to their conditional branches at every division inside the algorithm. Thus, the Applicant respectfully disagrees with the Examiner's conclusion that since the cited art is silent on conditional branching, "conditional branching or no conditional branching would be an option to one skilled in the art."

U.S. Patent No. 4,162,480 issued to Berlekamp ("Berlekamp") is introduced in to the rejection as "a teaching reference." The Office Action cites Berlekamp at column 27, lines 43-57 and column 69, lines 45-56 as suggesting the use of unconditional branches. It is respectfully submitted that Berlekamp provides no discussion or suggestion of obtaining a solution of said Yule-Walker equation without conditional branching. Thus, is Berlekamp provides no evidence of whether the prior art teaches or suggests solving Yule-Walker equations without conditional branching.

For that least these reasons, the Applicant respectfully submits that claim 5 is not obvious over the cited art and earnestly solicits allowance of the claim.

Claims 6-8

Claims 6-8 are dependent on further limit claim 5. Since claim 5 is believed allowable, claims 6-8 are also believed allowable for at least the same reasons as claim 5.

Claim 18

Claim 18 recites "The system according to claim 5, wherein means for obtaining the solution of said Yule-Walker equation is limited to addition and multiplication operations." In rejecting claim 18, the Office Action alleges that Zhang, at Table III, page 2997, teaches the limitations of claim 18. No other reference in the art is cited by the Examiner for teaching such a limitation.

Table III of Zhang is titled, "Numbers of Multiplication Required for Each Algorithm Where a/b: Forward or Backward Predictor to be Computed and a+b: Forward and Backward Predictors to be Computed." The table compares the number of multiplications of the Levinson, Euclidean and Berlekamp algorithms for both forward and backward predictors. The

Applicant respectfully submits, however, that nowhere in Zhang, including Table III, is there a teaching or suggestion that the solution of the Yule-Walker equation be limited to addition and multiplication operations, as recited in claim 18. Thus, the Applicant respectfully submits that the references of record do not teach or suggest the limitations of claim 18. As such, allowance of claim 18 is earnestly solicited.

Claim 9

Claim 9 recites, in part, "establishing a Yule-Walker equation . . . the elements of a Galois field $GF(2^m)$ applied to Reed-Solomon codes having an odd minimum distance." In rejecting claim 9, the Examiner alleges that Koga suggests a solution Reed-Solomon codes having an arbitrary minimum distance since the reference states, at column 14, lines 15-17, the "invention provides an error correction equipment with simple circuitry that can decode any received code word with reduced quantity of calculation." OA, pg. 2 and 9. The Applicant respectfully disagrees with the Examiner's interpretation of Koga.

Although Koga teaches error correction equipment with simple circuitry that can decode any received code word, this reference deals only with binary BCH codes since the syndrome relation $S_{2i}=S_i^2$ has to hold. Koga, col. 2, ln. 55-61. On the other hand, the technique of the present application is applicable to binary and non-binary codes over $GF(2^m)$. App., pg. 35, ln. 16-18. As further evidence, a more recent paper written by the same author, Koga, "A Simple Decoding of BCH Codes Over GF(2m)", IEEE Transactions on Communications, vol. 46, no. 6 (June 1998), submitted herewith in an Information Disclosure Statement, extends the Koga method to non-binary BCH codes over GF(2m). However, the paper also teaches that in order for ${}_{i;i+2u}D(X,Y)$ to exist for $u \leq t$ and to be used for error correction, there have to be 2t+1 syndromes, which makes the proposed method applicable only to even minimum distance codes.

The technique of the present invention has no such limitation since it does not need 2t+1 th syndrome S_{2t} thanks to the use of Jacobi's formula, even when the minimum distance is odd. In addition, this makes the present invention advantageous over Koga in the number of necessary multipliers.

Beyond the Koga reference, Examiner appears to take the position that the Yule-Walker equation can be applied to any Reed-Solomon code. In response, the Applicant respectfully requests evidence in the record demonstrating that it would be obvious to a person of ordinary skill in the art at the time the present invention was made that elements of a Galois field GF(2^m) applied to Reed-Solomon codes having an odd minimum distance, as recited in claim 9.

Thus, it is respectfully submitted that Ohira, in combination with Zang and Koga do not teach or suggest all the limitations of claim 9. For at least this reason, claim 9 is allowable.

<u>Claims 10-12</u>

Claims 10-12 are dependent on further limit claim 9. Since claim 9 is believed allowable, claims 10-12 are also believed allowable for at least the same reasons as claim 9.

<u>Claim 19</u>

Claim 19 recites "The program according to claim 9, wherein obtaining the solution of said Yule-Walker equation is limited to addition and multiplication operations." In rejecting claim 19, the Office Action alleges that Zhang, at Table III, page 2997, teaches the limitations of claim 19. No other reference in the art is cited by the Examiner for teaching such a limitation.

Table III of Zhang is titled, "Numbers of Multiplication Required for Each Algorithm Where a/b: Forward or Backward Predictor to be Computed and a+b: Forward and Backward Predictors to be Computed." The table compares the number of multiplications of the Levinson, Euclidean and Berlekamp algorithms for both forward and backward predictors. The Applicant respectfully submits, however, that nowhere in Zhang, including Table III, is there a teaching or suggestion that the solution of the Yule-Walker equation be limited to addition and multiplication operations, as recited in claim 19. Thus, the Applicant respectfully submits that the references of record do not teach or suggest the limitations of claim 19. As such, allowance of claim 19 is earnestly solicited.

Claim 22

Claim 22 recites "The program according to claim 9, wherein obtaining the solution of said Yule-Walker equation is performed without conditional branching." In rejecting this limitation the Examiner states, "the prior art of record is silent on conditional branching, which would lead one skilled in the art that conditional branching or no conditional branching would be an option to one skilled in the art." FOA, pg. 7. The Applicant respectfully disagrees with this conclusion.

As discussed in the pending Application, it is inevitable that multiple conditional branches would be included in the Berlekamp-Massey algorithm (to determine whether the denominator is zero or not). App., pg. 46, ln. 1-4. In the Euclid method, the degree of the polynomial that appears in the denominator of the division cannot be identified in advance; therefore there is a need to generate a conditional branch as well. App., pg. 46, ln. 7-14. It is noted that all possible computational paths must be statically implemented in advance in order for an algorithm to be realized as combination circuits. Although the existing algorithms such as Levinson, Berlekamp-Massey or Euclid could be implemented as combinational circuit, the resulting decoders would be have impractically large circuit size due to their conditional branches at every division inside the algorithm. Thus, the Applicant respectfully disagrees with the Examiner's conclusion that since the cited art is silent on conditional branching, "conditional branching or no conditional branching would be an option to one skilled in the art."

U.S. Patent No. 4,162,480 issued to Berlekamp ("Berlekamp") is introduced in to the rejection as "a teaching reference." The Office Action cites Berlekamp at column 27, lines 43-57 and column 69, lines 45-56 as suggesting the use of unconditional branches. It is respectfully submitted that Berlekamp provides no discussion or suggestion of obtaining a solution of said Yule-Walker equation without conditional branching. Thus, is Berlekamp provides no evidence of whether the prior art teaches or suggests solving Yule-Walker equations without conditional branching.

For that least these reasons, and the reasons given for claim 9, the Applicant respectfully submits that claim 22 is not obvious over the cited art and earnestly solicits allowance of the claim.

Claim 13

Claim 13 recites, in part, "establishing a Yule-Walker equation . . . the elements of a Galois field GF(2^m) applied to Reed-Solomon codes having an odd minimum distance." In rejecting claim 13, the Examiner alleges that Koga suggests a solution Reed-Solomon codes having an arbitrary minimum distance since the reference states, at column 14, lines 15-17, the "invention provides an error correction equipment with simple circuitry that can decode any received code word with reduced quantity of calculation." The Applicant respectfully disagrees with the Examiner's interpretation of Koga.

Although Koga teaches error correction equipment with simple circuitry that can decode any received code word, this reference deals only with binary BCH codes since the syndrome relation $S_{2i}=S_i^2$ has to hold. Koga, col. 2, ln. 55-61. On the other hand, the technique of the present application is applicable to binary and non-binary codes over GF(2^m). App., pg. 35, ln. 16-18. As further evidence, a more recent paper written by the same author, Koga, "A Simple Decoding of BCH Codes Over GF(2m)", IEEE Transactions on Communications, vol. 46, no. 6 (June 1998), submitted herewith in an Information Disclosure Statement, extends the Koga method to non-binary BCH codes over GF(2m). However, the paper also teaches that in order for ${}_{i;i+2u}D(X,Y)$ to exist for $u \leq t$ and to be used for error correction, there have to be 2t+1 syndromes, which makes the proposed method applicable only to even minimum distance codes.

The technique of the present invention has no such limitation since it does not need 2t+1 th syndrome S_{2t} thanks to the use of Jacobi's formula, even when the minimum distance is odd. In addition, this makes the present invention advantageous over Koga in the number of necessary multipliers.

Beyond the Koga reference, Examiner appears to take the position that the Yule-Walker equation can be applied to any Reed-Solomon code. OA, ¶ 2. In response, the Applicant respectfully requests evidence in the record demonstrating that it would be obvious to a person of ordinary skill in the art at the time the present invention was made that elements of a Galois field GF(2^m) applied to Reed-Solomon codes having an odd minimum distance, as recited in claim 13.

Thus, it is respectfully submitted that Ohira, in combination with Zang and Koga do not teach or suggest all the limitations of claim 13. For at least this reason, claim 13 is allowable.

Claims 14-16

Claims 14-16 are dependent on further limit claim 13. Since claim 13 is believed allowable, claims 14-16 are also believed allowable for at least the same reasons as claim 13.

Claim 20

Claim 20 recites "The storage medium according to claim 13, wherein obtaining the solution of said Yule-Walker equation is limited to addition and multiplication operations." In rejecting claim 20, the Office Action alleges that Zhang, at Table III, page 2997, teaches the limitations of claim 20. No other reference in the art is cited by the Examiner for teaching such a limitation.

Table III of Zhang is titled, "Numbers of Multiplication Required for Each Algorithm Where a/b: Forward or Backward Predictor to be Computed and a+b: Forward and Backward Predictors to be Computed." The table compares the number of multiplications of the Levinson, Euclidean and Berlekamp algorithms for both forward and backward predictors. The Applicant respectfully submits, however, that nowhere in Zhang, including Table III, is there a teaching or suggestion that the solution of the Yule-Walker equation be limited to addition and multiplication operations, as recited in claim 20. Thus, the Applicant respectfully submits that the references of record do not teach or suggest the limitations of claim 20. As such, allowance of claim 20 is earnestly solicited.

Claim 23

Claim 23 recites "The storage medium according to claim 13, wherein obtaining the solution of said Yule-Walker equation is performed without conditional branching." In rejecting this limitation the Examiner states, "the prior art of record is silent on conditional branching, which would lead one skilled in the art that conditional branching or no conditional branching would be an option to one skilled in the art." FOA, pg. 7. The Applicant respectfully disagrees with this conclusion.

As discussed in the pending Application, it is inevitable that multiple conditional branches would be included in the Berlekamp-Massey algorithm (to determine whether the denominator is zero or not). App., pg. 46, ln. 1-4. In the Euclid method, the degree of the polynomial that appears in the denominator of the division cannot be identified in advance; therefore there is a need to generate a conditional branch as well. App., pg. 46, ln. 7-14. It is noted that all possible computational paths must be statically implemented in advance in order for an algorithm to be realized as combination circuits. Although the existing algorithms such as Levinson, Berlekamp-Massey or Euclid could be implemented as combinational circuit, the resulting decoders would be have impractically large circuit size due to their conditional branches at every division inside the algorithm. Thus, the Applicant respectfully disagrees with the Examiner's conclusion that since the cited art is silent on conditional branching, "conditional branching or no conditional branching would be an option to one skilled in the art."

U.S. Patent No. 4,162,480 issued to Berlekamp ("Berlekamp") is introduced in to the rejection as "a teaching reference." The Office Action cites Berlekamp at column 27, lines 43-57 and column 69, lines 45-56 as suggesting the use of unconditional branches. It is respectfully submitted that Berlekamp provides no discussion or suggestion of obtaining a solution of said Yule-Walker equation without conditional branching. Thus, is Berlekamp provides no evidence of whether the prior art teaches or suggests solving Yule-Walker equations without conditional branching.

For that least these reasons, and the reasons given for claim 13, the Applicant respectfully submits that claim 23 is not obvious over the cited art and earnestly solicits allowance of the claim.

CONCLUSION

In view of the forgoing remarks, it is respectfully submitted that this case is now in condition for allowance and such action is respectfully requested. If any points remain at issue which the Examiner feels could best be resolved by a telephone interview, the Examiner is urged to contact the attorney below.

No fee is believed due with this Amendment, however, should a fee be required please charge Deposit Account 50-0510. Should any additional extensions of time be required, please consider this a petition thereof and charge Deposit Account 50-0510 the required fee.

Respectfully submitted,

Dated: September 12, 2006

Ido Tuchman, Reg. No. 45,924
Law Office of Ido Tuchman
82-70 Beverly Road
Kew Gardens, NY 11415
Telephone (718) 544-1110
Facsimile (718) 544-8588